My Ref. meetabst/IUGG99A.rtf IUGG99, Birmingham,UK. XXII Gen.Assy IUGG, 18-30 July 1999. Symposium JSV22
Abstract vol. p .B.113 (p. B.114 on CD ROM)

INTRUSIVE-SPLITTING OF TECTONIC PLATES AND LOG-JAM SEGREGATION OF MAGMAS: A NEW MECHANISM FOR INTRAPLATE MAGMATISM ON EARTH AND IN OTHER TERRESTRIAL BODIES

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The base of a large plate may be put into extension mechanically or by the penetration of cooling. Mantle cannot be split at low strain rates but its viscosity is highly temperature-sensitive and dependent on local composition. These may then combine to result in rapidly concentrated upward-necking of the plate. Sub-plate material thus drawn upward will undergo pressure-relief melting and eventually endow the column with net buoyancy to extend the narrow split up to the surface. Melt segregation will occur by a log-jam mechanism, well-known to grouting engineers and in other fields, in which the solids inevitably jam in the crack if they are bigger than 20-25% of the crack width. In our diapiric/intrusive column the jam will form when the solids grow again at shallower levels where wall cooling becomes important. The diapiric column will force melt through the jam. Continued opening of the crack will be offset by wall accretion; the jam will continually re-form and permit the segregation of flood basalts. Rupturing of jams provides a source of xenoliths. The self-generated diapiric capability of the column in the crack results in pressure around its base being sub-lithostatic, so low-melting and diffusible-gas mantle constituents will be drawn from a wider zone than the main melting, giving the magma a 'plume' signature (e.g. 3He and 87Sr) that is not of lower mantle origin. The mechanism offers a simple account of the alk-thol-alk-neph OIB sequence and of alkali basalts that precede or follow tholeiitic flood basalts. It also seems applicable to any terrestrial bodies with thermally shrinking global lithospheres.

[My talk also noted the following:- At MORs the continuity of the splitting process means that, at the outskirts of the basal zone of diapirically reduced pressure, material first has low-melting and gas constituents withdrawn from it along interstitial paths. But, as it approaches the base of the diapir at the centre of the zone, it will be re-enriched with those components from material that is further out, providing a self-cancelling effect of the ‘plume’ signature. N-MORB is the result; E-MORB is where this cancelling has failed. So the MORB-source mantle can be the same as that for IOB.]